MOTOROLA INC. COMMUNICATIONS DIVISION • **INSTRUCTION MANUAL**

TH-4
DC MULTIMETER
S1052B
TH-4

PORTABLE TRANSISTORIZED

DC

MULTIMETER

MODELS S1052B, S1063A

PRINTED IN U. S. A.

68P81012A35-B

MOTOROLA

PORTABLE TRANSISTORIZED DC MULTIMETERS

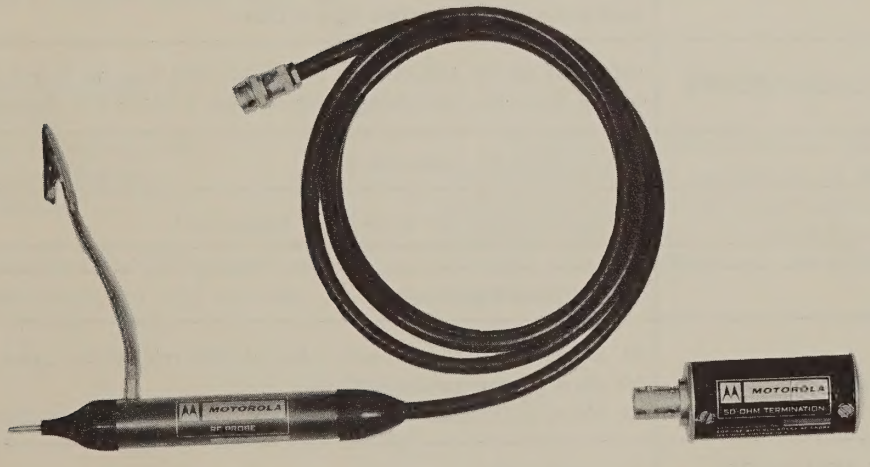
MODELS S1052B

S1063A

MC8709

Model S1063A
Portable Transistorized
DC Multimeter

MC8710



Model SLN6055A
RF Probe Accessory

Model SLN6083A
50 Ohm Termination

MOTOROLA INC. COMMUNICATIONS DIVISION

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Issue - B

GUARANTEED PERFORMANCE SPECIFICATIONS

MODEL	S1052B, battery operated, and S1063A, battery/a-c operated
VOLTAGE RANGES	±100 and 300 millivolts full scale ±1, 3, 10, 30, 100, 300 and 1000 volts full scale
CURRENT RANGES	±1, 3, 10, 30, 100 and 300 microamperes full scale ±1, 3, 10, 30, 100 and 300 milliamperes full scale
RESISTANCE RANGES	10, 100, 1000, 10,000, 100,000 ohms and 1 megohm center scale
ACCURACY (20°C - 30°C)	Voltage ranges: ±2% of full scale except ±3% of full scale on the two lowest ranges Current ranges: ±3% of full scale except ±5% of full scale on the three highest ranges Resistance ranges: ±5% at center scale
OPERATING TEMPERATURE	-20°C to +60°C
INPUT RESISTANCE	10 megohms on 0.1 volt range, 10.9 megohm on 0.3 volt range, 11 megohms on other voltage ranges
ZERO DRIFT	Less than 1% of full scale/°C Less than 0.1% of full scale/hr
OVERLOAD PROTECTION	VOLTS - 1000 volts plus range switch setting AMPS - 20 x range switch setting except on two highest ranges.
METER RESPONSE TO 60 CYCLES	With a 60 cycle signal 40 db above a d-c voltage the error caused is less than 2%
METER	0-200 microampere taut band movement (temp. comp.)
TRANSISTOR COMPLEMENT	10 silicon transistors
BATTERIES	1 Burgess type 4156 (22-1/2 v) or equiv. 1 Burgess type No. 130 (1-1/2 v) or equiv.
BATTERY LIFE	22-1/2 volt battery: Over 600 hours 1-1/2 volt battery: Essentially shelf life if ohmmeter is used intermittently. Over 100 hours for continuous ohmmeter operation.
AC INPUT REQUIREMENTS	(S1063A only) 105-130 v a-c, 50-400 cps at 5 ma (approx.) or 230 v a-c 50-400 cps using SKN6009A 230/117 v Adapter Cable Kit.
WEIGHT	7-1/4 pounds (approx.)
DIMENSIONS	10-1/4" x 6-1/2" x 5-3/4" (approx.)

MODEL	SLN6055A RF Probe
FREQUENCY RESPONSE	±1 db of full scale from 1 kc to 400 mc when used with SLN6083A 50 ohm probe termination. ±1 db of full scale from 1 kc to 100 mc with probe tip.
MAXIMUM AC VOLTAGE	10 volts rms
MAXIMUM DC VOLTAGE	400 volts rms

MODEL	SLN6083A 50 ohm Termination
MAXIMUM AC VOLTAGE	10 volts rms
MAXIMUM DC VOLTAGE	10 volts

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

FOREWORD

CLAIM FOR DAMAGE IN SHIPMENT

If any damage to the shipping container is apparent upon receipt, the delivering driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material have sustained damage.

The equipment should be unpacked immediately, examined for damage and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within forty-eight hours after receipt, if possible, or during a period not to exceed fifteen days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

Motorola Communications &
Electronics, Inc.
Parts and Service Department
4910 West Flournoy Street
Chicago 44, Illinois

Include model number and serial number when referring to the instrument for any reason. Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

REPAIR AND/OR RECALIBRATION

If desired the instrument may be returned to:

Motorola Communications &
Electronics, Inc.
Parts and Service Department
4910 West Flournoy Street
Chicago 44, Illinois

for repair and/or recalibration. Before shipping the instrument nofity the Parts and Service Department at the above address of the service required. Refer to the instrument by model number and serial number. On receipt of this information, you will be informed of shipping instructions. If requested, an estimate of the charges will be made before work begins, provided the instrument is not covered by the warranty.

SHIPPING

The instrument should be surrounded by two or three inches of excelsior or similar shock absorbing material and then packed in a strong exterior container. It should be shipped via Truck, Railway Express, Air Freight or Air Express.

WARRANTY

Motorola instrument equipment other than tubes, fuses, vibrators, and batteries is guaranteed by Motorola, for a period of one year after delivery to the original purchaser, against defects in design, material, and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory Service Department for that purpose and to replace any defective parts thereof.

Tubes and vibrators carry their own standard manufacturer's warranty of 90 days or 1000 hours, whichever first occurs.

This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at Motorola's then prevailing labor rate. In this case, an estimate will be submitted before the work is started.

This warranty is in lieu of all other warranties, expressed or implied and all other obligations or liabilities on Motorola's part.

If any fault develops, the following steps should be taken:

1. Notify us at the following address:

   Motorola Communications & Electronics, Inc.
   Parts and Service Department
   4910 West Flournoy Street
   Chicago 44, Illinois

   Give full details of the difficulty, and include model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid to the above address or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

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MODEL SLN6205A OHMMETER ADAPTER 68P81107A31

1. DESCRIPTION

The Motorola Model S1052B and S1063A Transistorized DC Multimeters are portable instruments for accurate measurement of r-f voltages, d-c voltages, d-c currents and resistance. Both d-c multimeters can be battery operated, however, a power cable (Model SKN6008A) and power supply included with the S1063A DC Multimeter permit it to be operated from an external 117 v a-c, 60 cps to 400 cps source. Although primarily designed for laboratory use, these instruments being self-powered and housed in a sturdy case, are quite applicable for field use without sacrificing the accuracy or versatility of a laboratory test instrument.

A Model SLN6055A RF Probe Accessory, fully described at the back of this instruction manual, is used with both d-c multimeter models. RF signals from 1 kc to 400 mc can be measured on the .3V, 1V, 3V and 10V full-scale multimeter ranges.

2. METERING FACILITIES

The meter is calibrated in two linear d-c voltage and current scales, two r-f scales and a resistance scale. Damping has been adjusted to eliminate "overshoot" for convenience in reading the pointer indication. The meter uses a 0-200 microampere, taut band movement. The meter scales and applications are as follows:

a. DC Voltage and Current Scales

The two linear scales are used in measuring d-c voltages and currents. The upper scale is graduated to a full scale value of 1.0, while the next scale down is graduated to a full scale value of 3.0. Using the full scale factors appearing on the range switch positions, all d-c voltages from 2 millivolts to 1000 volts and all d-c currents from .02 microampere to 300 milliamperes are read directly from these scales. The scales are color-coded red and black to correspond to color-coding of the function and range selector switch positions.

b. Resistance Scale

The lower scale is graduated from 0 to INF. with a center scale graduation of 10. Resistances are read directly from this scale using the multiplying factors appearing on the range switch positions. The scale is color-coded green to correspond to color-coding of the function and range selector switch positions.

c. RF Voltage Scales

RF voltages in the .3V and 1V range are read directly from the two middle scales (red). To measure r-f voltages greater than 1V, read directly from the two upper scales, using the full scale factor appearing at each range switch position.

3. CONTROLS AND ADJUSTMENTS

All controls and adjustments used for measurement are located on the front panel. These controls and adjustments include the following:

a. Mechanical Meter Zero

This is a screwdriver adjustment located on the meter cover. It is used to mechanically zero the meter in the event that the meter pointer does not rest in line with the zero line on the scale when the instrument is turned OFF.

b. Function Selector Switch

The OFF-B+ CHECK-RF VOLTS-VOLTS-OHMS-AMPS switch selects the various operating functions of the instrument. In order to reach the RF VOLTS, VOLTS, OHMS, or AMPS positions, the switch must be turned through the B+ CHECK position which meters the condition of internal battery.

c. Range Selector Switch

The range selector switch selects the various full scale ranges for use with the RF VOLTS, VOLTS or AMPS position or resistance multiplying factors for use with the OHMS position of the function selector switch.

d. Polarity Switch

The + (positive) and - (negative) positions of the polarity switch permit input polarity reversal without reversing the test lead connections. The BALANCE and ZERO SET positions are used when electrically zeroing the instrument.

e. Full Scale Resistance Adjustment

The INF. OHMS control adjusts the instrument for accurate full scale deflection previous to making resistance measurements.

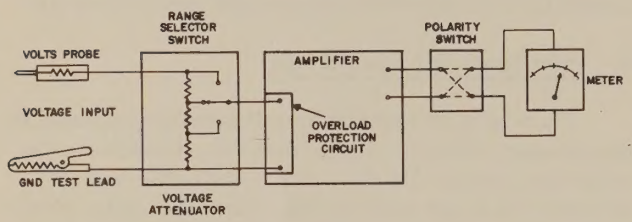
f. Zero Adjustment

The ZERO SET and BALANCE controls compensate for battery wear or other factors affecting the zero reference level of the amplifier and are used to electrically zero the instrument prior to use.

4. CIRCUIT DESCRIPTION

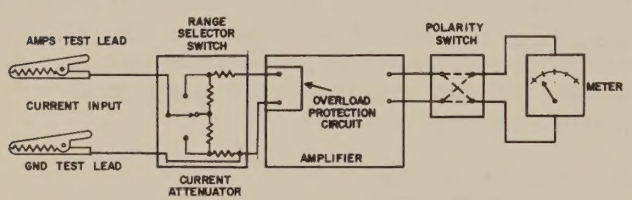
a. Input Attenuator

(1) Voltage Attenuator



This circuit is a voltage divider consisting of a series of resistances arranged in ratios of 1, 3, 10, 30, 100 etc. When the function selector switch is in the VOLTS position, input voltage from the test leads is applied across the entire attenuator. Taps on the attenuator output corresponding to the range selector switch settings apply a d-c voltage to the amplifier input through an overload protection circuit.

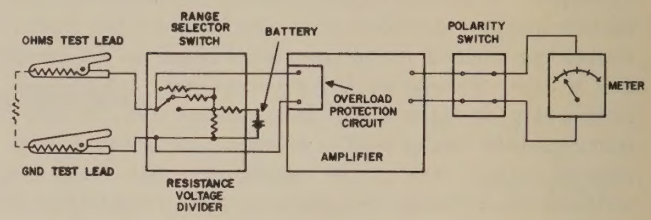
(2) Current Attenuator



The current attenuator consists of a series of shunt resistances through which the measured current flows. The resulting voltage drop across the shunt in use is applied to the amplifier input. A voltage drop of 100 millivolts across the shunt corresponds to full-scale meter deflection. Any voltage drop less than 100 millivolts results in on-scale readings.

The ability of the shunts to withstand overloads is determined by the power rating of the shunt resistance in use. The ranges from 1 microampere to 3 milliamperes use 1/2 watt resistors. The remaining four ranges use 1 watt resistors.

(3) Resistance Voltage Divider



Battery voltage is reduced through a voltage divider resulting in a basic voltage source of about 0.15 volt in series with 10 ohms on the R x 1 range. Additional resistances are inserted in series with the basic 10 ohms on the remaining ranges. Voltage from the output of this circuit is applied directly to the test leads. Amplifier input voltage is determined by the voltage drop across the external resistance as derived from the voltage applied to the test leads.

b. Amplifier and Overload Protection Circuit
Refer to Schematic Diagram

(1) Amplifier

The amplifier consists of five differential direct coupled, transistorized stages. Negative feedback of 60 db is provided to ensure gain stability. In addition, this feedback raises the amplifier input impedance to a very high value to prevent loading of the multimeter high impedance input circuitry. The amplifier is capable of measuring both positive and negative voltage inputs.

Voltage applied to the input of the amplifier shifts the base of transistor Q1 positive and the base of transistor Q2 negative. This voltage change is amplified by succeeding stages. The fifth stage, Q9 and Q10, drives a 200 microampere meter movement. One half of the voltage across the meter is fed back to the emitters of the input stage transistors, Q1 and Q2. This negative feedback voltage applied to the base of the input transistors, nearly balances the input voltage and raises the input impedance to a high value.

Common emitter resistors reduce the common mode gain of the amplifier while still

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allowing a high differential gain. Filter capacitors at the amplifier input form a low-pass filter to limit the amplifier input to d-c, and low a-c frequencies.

The amplifier has two zero adjustments; a ZERO SET (open circuit zero) and a BALANCE (short circuit zero) adjustment. These zero sets require occasional adjustment and, once set, will zero the meter for all ranges.

Amplifier gain is adjusted by the INF-OHMS control on the resistance ranges so that a full scale reading corresponds to the basic battery voltage. Short circuiting the test leads corresponds to measuring zero resistance.

(2) Overload Protection Circuit

This circuit sets a limit on the maximum voltage applied to the amplifier input. Voltage in excess of the ignition potential of the neon bulb in the protection circuit causes the bulb to conduct and clamp at approximately 100 volts. The voltage existing across the bulb is applied to a circuit consisting of resistors and two paralleled diodes (forward and reversed). These diodes limit the voltage applied to the first transistor pair in the amplifier.

c. Meter Circuit

The meter circuit consists of the meter, voltage calibration control, current calibration control and INF. OHMS control in series across the amplifier output. The meter movement is temperature compensated and has an internal resistance of 900 ohms. A taut-band suspension system provides the meter movement with highly reliable, frictionless operation.

d. Function Selector Switch

The function selector switch performs the following functions in the RF VOLTS, VOLTS, AMPS-OHMS and B+ CHECK position:

(1) RF VOLTS Position

(a) Connects the RF VOLTS jack to the attenuator.

(b) Disconnects both the VOLTS and AMPS-OHMS test leads.

(c) Bypasses the current calibration and INF. OHMS controls in the meter circuit.

(2) VOLTS Position

(a) Connects the VOLTS test lead to the attenuator.

(b) Bypasses the current calibration and INF. OHMS controls in the meter circuit.

(c) Disconnects the AMPS-OHMS test lead.

(d) Disconnects the RF VOLTS jack.

(3) AMPS Position

(a) Disconnect the VOLTS test lead.

(b) Bypasses the INF. OHMS control in the meter circuit.

(c) Connects the AMPS-OHMS test lead to the input shunts.

(d) Disconnects the RF VOLTS jack.

(4) OHMS Position

(a) Disconnects the VOLTS test lead.

(b) Connects the AMPS-OHMS test lead to the internal battery source and the resistance voltage divider.

(c) Disconnects the RF VOLTS jack.

(5) B+ CHECK Positions

(a) Disconnects the RF VOLTS jack, the VOLTS and AMPS-OHMS test leads.

(b) Disconnects the meter circuit from the amplifier output and connects the meter through an appropriate multiplying resistor to the batteries.

NOTE

In the B+ CHECK position, the amplifier is energized and the B supply battery condition and/or the power supply of the S1063A under load is indicated on the meter.

e. Polarity Switch

The output of the amplifier is connected to the meter circuit through the polarity switch. A positive (+) output from the amplifier will pro-

duce on-scale readings with the polarity switch in the + OHMS position. The switch must be placed in the - (negative) position reversing the amplifier output connections to the meter circuit when the amplifier produces a negative (-) output. In the ZERO SET position, the normal input to the amplifier is disconnected and a 5.6 megohm resistor is substituted. In the BALANCE position the normal input to the amplifier is disconnected and a short is placed across the amplifier input.

5. BATTERY INSTALLATION

The batteries are not installed in the instrument as it is shipped from the factory. Install the batteries as described in the MAINTENANCE AND ADJUSTMENT section of this manual.

6. PRELIMINARY OPERATING PROCEDURE

Perform the following operational checks before placing the instrument in service.

a. Mechanical Meter Zero

A screwdriver adjustment located on the meter cover permits adjustment of the pointer to mechanical zero. If the pointer does not rest in line with the 0 line of the scales when the function selector switch is in the OFF position, turn the adjusting screw left or right until the pointer is in line with the 0 line.

b. Battery or Power Supply Condition

(1) To test the battery condition of the Model S1052B Multimeter, perform steps (3) and (4).

(2) To test the battery or power supply condition of the Model S1063A Multimeter, place the switch at the back of the multimeter housing in either the BATT. or LINE position. Perform steps (3) and (4).

(3) Place the function selector switch in the B+ CHECK position and the polarity switch in any position except the - (negative) position. If the meter pointer does not come up to the B+ O. K. line on the scale, refer to the MAINTENANCE AND ADJUSTMENT section of this manual and replace BT1.

(4) Place the function selector switch in the OHMS position, the polarity switch in the ZERO SET position, and the range selector switch in one of the resistance ranges (R x 1 etc). Adjust the ZERO SET for a zero reading on the OHMS scale. Place the polarity switch in the + OHMS position and adjust the INF. OHMS control for an INF. reading on the meter. Be sure that the ANPS-OHMS and GND test leads are disconnected from external circuitry and are not short-circuited when making this adjustment. If the INF. reading cannot be obtained, refer to the MAINTENANCE AND ADJUSTMENT section of this manual and replace BT2.

7. OPERATION

NOTE

For proper operation of a-c powered multimeters, the external ground pin of the a-c power cable plug must be grounded.

a. Voltage Measurement

(1) Place the function selector switch in the VOLTS position (color-coded red).

(2) Allow 1/2 minute for capacitors to charge up.

(3) Place the range selector switch in the least sensitive voltage range position (1000 VOLTS). The voltage ranges are color-coded red on the front panel of the instrument.

(4) Place the polarity switch in the BALANCE position. Make a screwdriver adjustment through the hole marked BALANCE until the meter pointer is in line with the 0 of the scale.

(5) Place the polarity switch in the ZERO SET position and adjust the ZERO SET control until the meter pointer is in line with the 0 of the scale.

(6) Repeat step (4), then step (5).

(7) If the multimeter is left "on" for long periods of time, repeat step (4), then step (5).

(8) Place the polarity switch in the + OHMS position.

(9) Connect the black GND test lead clip to the negative (-) side of the voltage source being measured.

(10) Place the probe tip of the gray shielded VOLTS test lead at the positive (+) side of the voltage source being measured. A 1 megohm resistor is in series with the probe and test lead for a-c isolation purposes.

NOTE

If the meter deflects to the left off scale, it is not necessary to reverse the test

NOTE (Cont'd)

leads. Place the polarity switch in the - (negative) position. The circuit being measured will not be overloaded as the polarity switch passes through the ZERO SET position.

(11) Place the range selector switch progressively in more sensitive voltage ranges until a reading as near full-scale as possible is obtained. Readings in the upper portion of the scale are the most accurate and ranges should be selected to accomplish this whenever possible. The instrument will withstand applications of over-voltage of up to 1000 volts plus the range switch setting in the event an oversensitive range is selected.

WARNING

In a-c/battery operated models, the housing is grounded to the power line ground when the slide switch on the back of the housing is in the LINE, i.e. a-c, position.

When the slide switch is in the BATT. position, the case is not grounded to the power line ground, but the multimeter GND lead is grounded to the case through a .47 uf/400 v capacitor. This capacitor can charge up when the case is accidently grounded to the power line ground, with the multimeter GND lead at high potential. Therefore, the multimeter housing must not be connected to the power line ground during battery operation. Should the housing be accidentally grounded, the capacitor should be discharged by touching the GND lead to the housing.

The conditions described in the preceding paragraph also apply to the battery operated S1052B Multimeter.

b. RF Voltage Measurement

Refer to the RF PROBE ACCESSORY section of this instruction manual for r-f volt measurement procedure.

c. Current Measurement

(1) Gradually move the function selector switch through the B+ CHECK, RF VOLTS, VOLTS and OHMS positions to the AMPS position.

(2) Allow a 1/2 minute stabilization period as described in step (2) of "Voltage Measurement" if the instrument has not been in use.

(3) Place the range selector switch in the least sensitive current range (300 MILLI). Current ranges are color-coded black on the front panel.

(4) Place the polarity switch in the BALANCE position. Make a screwdriver adjustment through the hole marked BALANCE until the meter pointer is in line with the 0 of the scale.

(5) Place the polarity switch in the ZERO SET position and adjust the ZERO SET control until the meter pointer is in line with the 0 of the scale.

(6) Repeat step (4), then step (5).

(7) If the multimeter is left "on" for long periods of time, repeat step (4), then step (5).

(8) Place the polarity switch in the + OHMS or - (negative) position.

(9) Connect the instrument in series with the current flow. Use the black GND test lead clip and the red AMPS-OHMS test lead clip. If the meter deflects to the left off-scale, place the polarity switch in the opposite polarity position + OHMS or - (negative) from its present setting. Reversing the test lead connections is not necessary. The input shunt resistance is still in series with the current source when the polarity switch is in the ZERO SET position. The circuit being measured will not be appreciably disturbed when switching through this position.

WARNING

In a-c/battery operated models, the housing is grounded to the power line ground when the slide switch on the back of the housing is in the LINE, i.e. a-c, position.

When the slide switch is in the BATT. position, the case is not grounded to the power line ground, but the multimeter GND lead is grounded to the case through a .47 uf/400 v capacitor. This capacitor can charge up when the case is accidentally grounded to the power line ground, with the multimeter GND lead at high potential. Therefore, the multimeter housing must not be connected to the power line ground during battery operation. Should the housing be accidentally grounded, the capacitor should be discharged by touching the GND lead to the housing.

The conditions described in the preceding

WARNING (Cont'd)

paragraphs also apply to the battery operated S1052B Multimeter.

CAUTION

Although the amplifier is protected by an overload protection circuit and the instrument will withstand severe overloads (20 x range switch setting on all but 2 highest ranges), damage to switches and resistors may result if excessive currents are applied.

d. Current Range Input Resistance

The resistance of any current range is obtained by dividing 100 millivolts by the full scale current of the current range being used. Table I indicates the resistance of all current ranges.

TABLE I

Range	Resistance (ohms)
1 ua	100K
3 ua	100/3K
10 ua	10K
30 ua	10/3K
100 ua	1K
300 ua	1/3K
1 ma	100
3 ma	100/3
10 ma	10
30 ma	10/3
100 ma	1
300 ma	1/3

e. Current Measurements Lower Than 1 Microampere

It is possible to measure current less than the lowest specified range (1 ua full scale) with limited accuracy. However, Motorola does not guarantee these measurements for accuracy. To make this measurement, set the function selector switch to the volts position and use the voltage leads. Set the range selector switch in either the 3 volt, 1 volt, 300 millivolts or 100 millivolts range. Divide the voltage measured, by the specified input resistance of the scale being used. Refer to the Guaranteed Performance Specifications at the front of this manual for input resistance. For greater accuracy of measurement use the measured value of input resistance.

EXAMPLE

Assume the voltage measured is 50 millivolts on the 100 millivolt range, input resistance on this range is 10 megohms.

$$\frac{50 \text{ mv}}{100 \text{ megohms}} = .005 \text{ microampere}$$

f. Current Measurements Higher Than 300 Milliamperes

Currents higher than 300 milliamperes can be measured by using the multimeter as a voltmeter to measure the voltage across (and thereby the current through) a calibrated resistor soldered or connected in the circuit under measurement.

For example, to measure 1 ampere full scale, use a 1 ohm resistor and the 1-volt range or any other combination of resistor and voltage range as shown in Table II. With the 1 ohm resistor and 1-volt range combination, full scale reading will be 1 ampere and half scale reading will be .5 ampere. Thus, current can be read directly on the voltage range. The maximum percentage of error will be the percentage of accuracy of the voltage range plus the percentage of tolerance of the resistor used.

g. Resistance Measurement

(1) Place the function selector switch in the OHMS position.

(2) Allow a 1/2 minute stabilization period as described in step (2) of "Voltage Measurements", if the instrument has not been in use.

(3) Place the range selector switch in the desired resistance range. The resistance ranges are color-coded green on the front panel.

TABLE II

Calibrated Resistor Value	Resistor Minimum Wattage	Circuit Voltage Drop *	Use Multimeter Range	Read Amps on Multimeter Top Scale
0.1 ohm	0.1 watt	100 mv	100 mv	0-1.0
0.3 ohm	0.3 watt	300 mv	300 mv	0-1.0
1.0 ohm	1.0 watt	1.0 volt	1.0 volt	0-1.0
↓	↓	↓	↓	↓
1000 ohms	1000 watts	1000 volts	1000 volts	0-1.0

* At 1 ampere through the calibrated resistor

(4) Place the polarity switch in the BALANCE position. Make a screwdriver adjustment through the hole marked BALANCE until the meter pointer is in line with the 0 of the scale.

(5) Place the polarity switch in the ZERO SET position and adjust the ZERO SET control until the meter pointer is in line with the 0 of the scale.

(6) Repeat step (4), then step (5).

(7) If the multimeter is left "on" for long periods of time, repeat step (4), then step (5).

(8) Place the polarity switch in the + OHMS position.

(9) Adjust the INF. OHMS control until the meter pointer is in line with the INF. line of the scale. Be sure that the AMPS-OHMS and GND test leads are disconnected from external circuitry and are not short-circuited when making this adjustment.

NOTE

The instrument will detect the presence of resistance in its own test leads. For greatest accuracy on the lowest resistance ranges (R x 1 and R x 10) the black GND and red AMPS-OHMS test leads should be shorted at the clips and the polarity switch placed in the + OHMS position when performing the zero adjustment.

(10) Connect the black GND test lead clip and the red AMPS-OHMS test lead clip across the resistance to be measured. The polarity of the voltage present at the test clips is positive (+) at the red lead and negative at the black lead.

CAUTION

Do not attempt resistance measurements in energized circuits.

(11) Place the range selector switch progressively in more sensitive ranges until a reading as near center-scale as possible is obtained. Readings in the center portion of the scale are the most accurate and ranges should be selected to accomplish this whenever possible.

NOTE

Check the ZERO SET and INF. OHMS adjustments when switching ranges and periodically after the instrument has been "on" for extended periods.

h. Open Circuit Voltages, Source Resistances, and Short Circuit Currents

The open circuit voltages, source resistances, and short circuit currents (when ohmmeter leads are shorted together) for all ohmmeter ranges are shown in Table III.

Since maximum open circuit voltage is limited to 0.15 v and the maximum short-circuit current is limited as indicated in Table III, "in-circuit" resistance measurements may be made without the need to unsolder the semiconductors in the circuit being measured. These limitations of voltage and current also prevent accidental damage to semiconductors when they are being tested.

8. APPLICATIONS

Excellent sensitivity, high input resistance, low voltage drop in current measurement, and low voltage application in resistance measurement combine to make the instrument extremely useful for measurements in transistor circuits as well as conventional vacuum tube circuits. Many measurements impossible with typical vacuum tube instruments are accurately and easily obtained. The following list indicates a few of the many difficult measurements the instrument is capable of performing.

TABLE III

Ohmmeter Range	R x 1	R x 10	R x 100	R x 1K	R x 10K	R x 100K
Source Resistance	10 ohms	100 ohms	1 K-ohm	10 K-ohms	100 K-ohms	1 Megohm
Open Circuit Voltage	0.15 v	0.15 v	0.15 v	0.15 v	0.15 v	0.15 v
Short Circuit Current	15 ma	1.5 ma	150 ua	15 ua	1.5 ua	0.15 ua

a. Voltage drop across emitter-base junction.

b. Voltage across emitter resistors (checking bias).

c. Collector-base reverse current (I_{co}).

d. Limiter and discriminator bias.

e. Oscillator grid bias.

f. Resistance of temperature sensitive devices (thermistors etc.)

g. Resistance measurements in transistorized circuits without biasing transistors into conduction.

h. Floating measurements - negative lead is not grounded.

i. Transistor leakage currents (current sensitivity of 10 nano - amperes F. S. when using 100 mv range and external d-c supply).

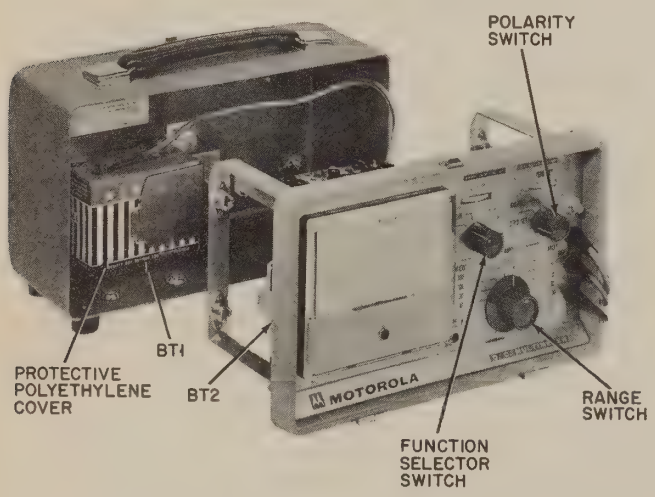
j. Tantalum capacitor leakage current.

5. MAINTENANCE AND ADJUSTMENT

a. Battery Replacement

(1) Place the instrument face down on a padded surface.

(2) Loosen four captive screws in rear cover and remove cover from chassis.



(3) Loosen the captive screw holding the battery mounting clamp to the rear cover.

(4) Remove battery mounting clamp and BT1 from rear cover.

(5) Remove nuts and connecting strip from BT1 and connect to a new 22-1/2 volt battery (Burgess type 4156 or equivalent).

CAUTION

It is important for proper operation of this instrument that the battery does not come into direct contact with any metal parts of the instrument housing. For this reason, it is essential to insert the battery into the protective polyethylene cover before installing the battery in the instrument.

Connect the red lead to the positive (+) terminal and the black lead to the negative (-) terminal of the battery.

(6) Position battery in rear cover as shown and replace mounting clamp.

(7) Remove BT2 from mounting bracket or multimeter chassis. Insert new 1-1/2 volt "C" type cell (Burgess No. 130 or equivalent) with positive (+) terminal located at end of mounting bracket where leads are connected.

(8) Replace rear cover and tighten four captive screws. Place the instrument in operating position and check BT1 installation by placing function selector switch in B+ CHECK position and the polarity switch in any position except the - (negative) position. Meter indication should be beyond B+ O.K. line.

(9) To check BT2, place the function selector switch in OHMS position and polarity switch in ZERO SET position. Adjust ZERO SET control for 0 indication on meter. Place polarity switch in + OHMS position. INF. OHMS adjustment should readily bring meter pointer to INF. line on meter scale with range selector switch in any of the resistance range positions when the AMPS-OHMS and GND test leads are disconnected from external circuitry and not short-circuited.

b. Calibration

Periodic calibration is recommended to preserve the accuracy of the instrument. In average use, the instrument should be calibrated at least once every six months.

(1) Equipment Required

(a) Voltage source (1.0 v d-c ±0.5% minimum accuracy).

(b) Current source (100 microamperes ±0.5% minimum accuracy).

(2) Preliminary Procedure

(a) Place instrument on its feet with function selector switch in OFF position.

AEPD-10615-O(MC8708)

(b) Adjust mechanical meter zero for 0 indication on meter.

(c) Remove plug buttons in bottom of instrument case to gain access to calibration adjustments and loosen locknuts on control shafts.

(d) Place function selector switch in VOLTS position, polarity switch in BALANCE position, range selector switch in 1.0 VOLTS position and allow a 30 second period for capacitors to charge up.

NOTE

Calibration should always be performed with the rear cover in place, to avoid noise pick-up. Make voltage calibration first, then current calibration.

(3) Voltage Calibration

(a) Place polarity switch in BALANCE position and adjust the BALANCE control for 0 indication on meter.

(b) Place polarity switch in ZERO SET position and adjust the ZERO SET control for 0 indication on meter.

(c) Place polarity switch in + OHMS position.

(d) Connect VOLTS test lead probe to positive (+) side and GND test lead clip to negative (-) side of 1.0 v d-c source.

(e) Adjust calibration control nearest center of instrument for full-scale reading on VOLTS scale.

(f) Repeat the voltage calibration procedure.

(g) Tighten locknut.

(4) Current Calibration

(a) Place function selector switch in AMPS position, and range selector switch in 100 MICROAMPS position.

(b) Check amplifier BALANCE and adjust BALANCE control if necessary to obtain 0 meter indication.

(c) Check electrical zero and adjust ZERO SET if necessary to obtain 0 meter indication.

(d) Place polarity switch in + OHMS position.

(e) Connect AMPS-OHMS and GND test lead clips in series with 100 microampere d-c current source.

(f) Adjust calibration control nearest outside of meter case for full-scale meter reading.

(g) Repeat the previous current calibration steps.

(h) Tighten locknut and replace plug buttons in bottom of instrument case.

NOTE

The instrument may be returned to the factory for calibration if desired. Refer to the FOREWORD section of this manual for detailed information.

c. Temperature Limitations

As with most precision measuring equipment, this instrument has certain temperature limitations. Under normal temperatures, it will yield accurate readings. Care should be exercised to avoid operation and storage in temperatures above 140°F or 60°C. Storage at temperatures of less than -40°F or C should also be avoided. The following table will provide an idea of accuracy as influenced by temperature.

TABLE IV
Typical Temperature Performance Limits

Function	Temp. °C	Temp. °F	Tolerance F.S.
VOLTS	-20	-4	+3% to -5%
	0	+32	±3%
	+60	+140	+3% to -5%
AMPS	-20	-4	+3% to -5%
	0	+32	±3%
	+60	+140	+3% to -5%
OHMS	-20	-4	±5%
	0	+32	±3%
	+60	+140	±5%

d. Servicing and Parts Replacement

(1) Attenuator Failure

Attenuator failure may be indicated by

(a) meter readings of 0.1 volt regardless of the range switch setting (b) lack of meter indication on the more sensitive current ranges (c) off-scale indication when an attempt is made to adjust the INF. OHMS control.

(a) If meter readings of 0.1 volt are obtained regardless of the range switch setting, inspect the range switch and check for evidence of an open resistor in the attenuator circuit.

(b) If readings are not obtained in the more sensitive current ranges, inspect the range switch and check for evidence of an open shunt resistor.

(c) If off-scale meter indications occur when attempting to adjust the INF. OHMS control, check the 11.1 ohm resistor on the function selector switch for incorrect value or open circuit.

(2) Unstable Meter Pointer

An unstable meter pointer may indicate (a) condensation (b) contamination or (c) defective low-pass filter circuit.

(a) Storage of the instrument in very humid atmospheres or a change in ambient temperature from cold to warm can result in condensation on circuitry, as evidenced by erratic operation. Place the instrument in a dry atmosphere and allow to dry out thoroughly.

(b) Check for contamination of tie points in the overload protection circuit, at the base of the input transistor pair Q1 and Q2, ceramic sections of switches and the base of the neon bulb. If contamination is present, wash these areas carefully with denatured alcohol.

CAUTION

Contamination will result if fingers are placed on the neon bulb or its teflon standoffs.

(c) Carefully check and replace defective polystryene capacitors in the low-pass filter circuit.

(3) Battery Corrosion

Serious battery corrosion may occur if the instrument is not used or stored for long periods of time with the batteries in place. If this occurs, proceed as follows:

(a) Remove the batteries and the rubber mounting pad from the rear cover.

(b) Wash corrosion from affected areas with a mild detergent.

(c) Cement new or washed and thoroughly dried rubber mounting pad in place.

(d) Clean the connections to the batteries.

(e) Install new batteries and battery jacket.

(4) VOLTS Test Lead

The VOLTS test lead is a stranded conductor, polyethylene insulated, shielded cable. The shielding is a black conductive vinyl inner jacket. This jacket must always be clamped to the bracket behind the front panel.

NOTE

The outer gray jacket of the test lead may be cemented to the probe with one or two drops of acetone to prevent the test lead from twisting.

(5) AC Power Supply Failure

No readings during a B+ CHECK of a-c powered multimeters may indicate a loose connection and/or power supply failure.

(a) Perform a B+ CHECK with the multimeter switched to battery operation. Normal readings indicate the meter circuit is operating and the a-c power supply has failed.

(b) Check power supply components for changes in value, open circuits or shorts. Normal power supply voltages (under load) are approximately 22.5 v d-c across capacitor C103 and 11 v a-c at the secondary of transformer T101.

(6) Amplifier Failure

Amplifier failure, as well as failure in circuits and components directly associated with the amplifier, may be indicated by lack of meter response when using the instrument for voltage, current or resistance measurement. Improper amplifier operation may result in inability to electrically zero the instrument. To determine if associated circuits or components are the source of failure, perform the following tests.

(a) Check the meter circuit by first installing new batteries in the multimeter. Then place the function selector switch in the B+ CHECK position and the polarity switch in the ZERO SET or + (positive) position. Normal readings indicate proper meter circuit operation.

(b) Check the interconnecting leads to the fourth section of the function selector switch for open circuits or bad connections.

(c) If the instrument will not zero electrically, check the ZERO SET and BALANCE controls, and their interconnecting leads for continuity.

Amplifier failure is indicated if none of the preceding tests reveal the malfunctioning area. It is then recommended that the instrument be returned to the factory for servicing. Refer to the FOREWORD of this instruction manual for detailed information.

CAUTION

The amplifier board is coated with a moisture-proof varnish. Do not make any voltage measurements as it may destroy the coating.

10. MODEL SLN6055A RF PROBE ACCESSORY

a. Description

The Model SLN6055A RF Probe Accessory is used with both the Model S1052B and S1063A Transistorized DC Multimeters. This accessory enables the measurement of r-f signals from 1 kc to 400 mc on the multimeter .3V, 1V, 3V, and 10V full-range scales. The r-f probe consists of a shielded probe, ground lead and four feet of shielded cable connected to a miniature BNC connector. The typical r-f probe input capacitance is 3 to 4 micromicrofarads. The low frequency input impedance at 1 kc is 600 K.

b. Guaranteed Performance Specifications

MODEL	SLN6055A RF PROBE
FREQUENCY RESPONSE	±1 db of full scale from 1 kc to 400 mc when used with SLN6083A 50 ohm probe termination ±1 db of full scale from 1 kc to 100 mc with probe tip
MAXIMUM AC VOLTAGE	10 volts rms
MAXIMUM DC VOLTAGE	400 volts

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

c. Circuit Description

The r-f probe, as shown in Schematic Diagram 63A81012A38, is a peak-reading, shunt type rectifier using a semiconductor diode. When the r-f probe is connected to a multimeter, and the probe tip and ground lead are applied to an r-f source, capacitor C1 charges through forward biased diode CR1 on the positive swing of the r-f signal. During the negative swing of the r-f signal, capacitor C1 starts to discharge through resistor R1 and the multimeter input circuitry. The discharge rate of capacitor C1 is considerably longer than the duration of the rectified r-f pulse. This provision keeps the voltage existing across capacitor C1 very near the input voltage peak during the negative portion of the r-f swing. Successive positive r-f inputs maintain the voltage across capacitor C1, to establish a direct relation between input r-f voltage peaks and the voltage developed across the multimeter input circuitry. The circuit time constant, resulting from the proper value selection of C1, CR1, R1 and the input impedance of the multimeter, ensures r-f probe accuracy for frequencies ranging from 1 kc to 400 mc.

d. RF Voltage Measurement

(1) Connect the probe BNC connector to the RF VOLTS jack on the S1052B or S1063A Model Multimeter.

(2) Place the function selector switch in the RF VOLTS position.

(3) Allow a 1/2 minute stabilization period for capacitors to charge up.

(4) Place the range selector in the least sensitive r-f voltage range (10V).

(5) Place the polarity switch in the BALANCE position. Make a screwdriver adjustment through the hole marked BALANCE until the meter pointer is in line with the 0 of the scale.

(6) Place the polarity switch in the ZERO SET position and adjust the ZERO SET control until the meter pointer is in line with the 0 of the scale.

(7) Repeat step (5) and then step (6).

(8) If the multimeter is left "on" for long periods of time, repeat step (5) then step (6).

(9) Place the polarity switch in the + (positive) position.

(10) Connect the r-f probe ground clip to the r-f source circuit ground.

(11) Place the probe tip at the r-f voltage source to be measured.

(12) Place the range selector switch in progressively more sensitive voltage ranges until a reading as near full-scale as possible is obtained.

NOTE

Use the upper two scales (black coded) for r-f measurements within the 10 volt and 3 volt range. Use the center two scales (red coded) for r-f measurements within the .3 volt range and the 1 volt range.

e. Measurement Considerations

The r-f probe is a half-wave peak type detector that is calibrated in rms. Therefore an error can be introduced if a non-sinusoidal waveform is measured.

11. MODEL SLN6083A 50 OHM TERMINATION

a. Description

The Model SLN6083A 50 Ohm Termination is an accessory item to the Model SLN6055A RF Probe Accessory. The unit attaches to the r-f probe and provides the proper termination required for r-f voltage measurements up to 400 mc (±1 db). The unit consists of two 100 ohm, 1 watt resistors (±1%) connected in parallel and contained in a cylindrical housing. One end of the unit is threaded for attachment to the Model SLN6055A RF Probe and the other end has a BNC (female) connector.

b. Guaranteed Performance Specifications

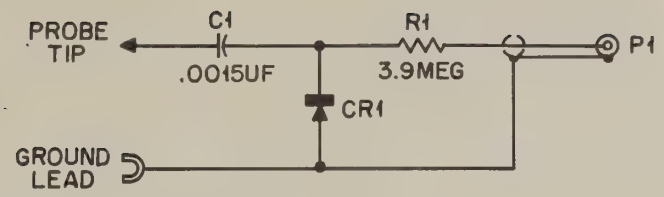
MODEL	SLN6083A 50 OHM TERMINATION
MAXIMUM AC VOLTAGE	10 volts rms
MAXIMUM DC VOLTAGE	10 volts

c. Parts List

MOTOROLA PART NO.	DESCRIPTION
6D82475B57	RESISTOR, fixed 100; ±1%; 1 w; 2 req'd
9B855268	CONNECTOR, BNC
1V80727A82	ASSY. INSULATOR CONTACT RIVET

12. MODEL SKN6009A 230/117 VOLT ADAPTER CABLE

The Model SKN6009A 230/117 Volt Adapter Cable is used with the line operated Model S1063A Transistorized DC Multimeter in areas serviced with 230 volt a-c line power. The adapter cable consists of approximately six feet of 3-conductor cable, a small cylindrical housing containing a potted step-down transformer and a 3-pin connector which mates with the plug on the d-c multimeter power cable (Model SKN6008A). An a-c line plug is not supplied with the cable due to the lack of standardization on the types used. When connecting an a-c line plug, connect the BLK and WHT leads to the 230 volt line and connect the GRN lead to ground.



MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
SLN6055A		RF PROBE

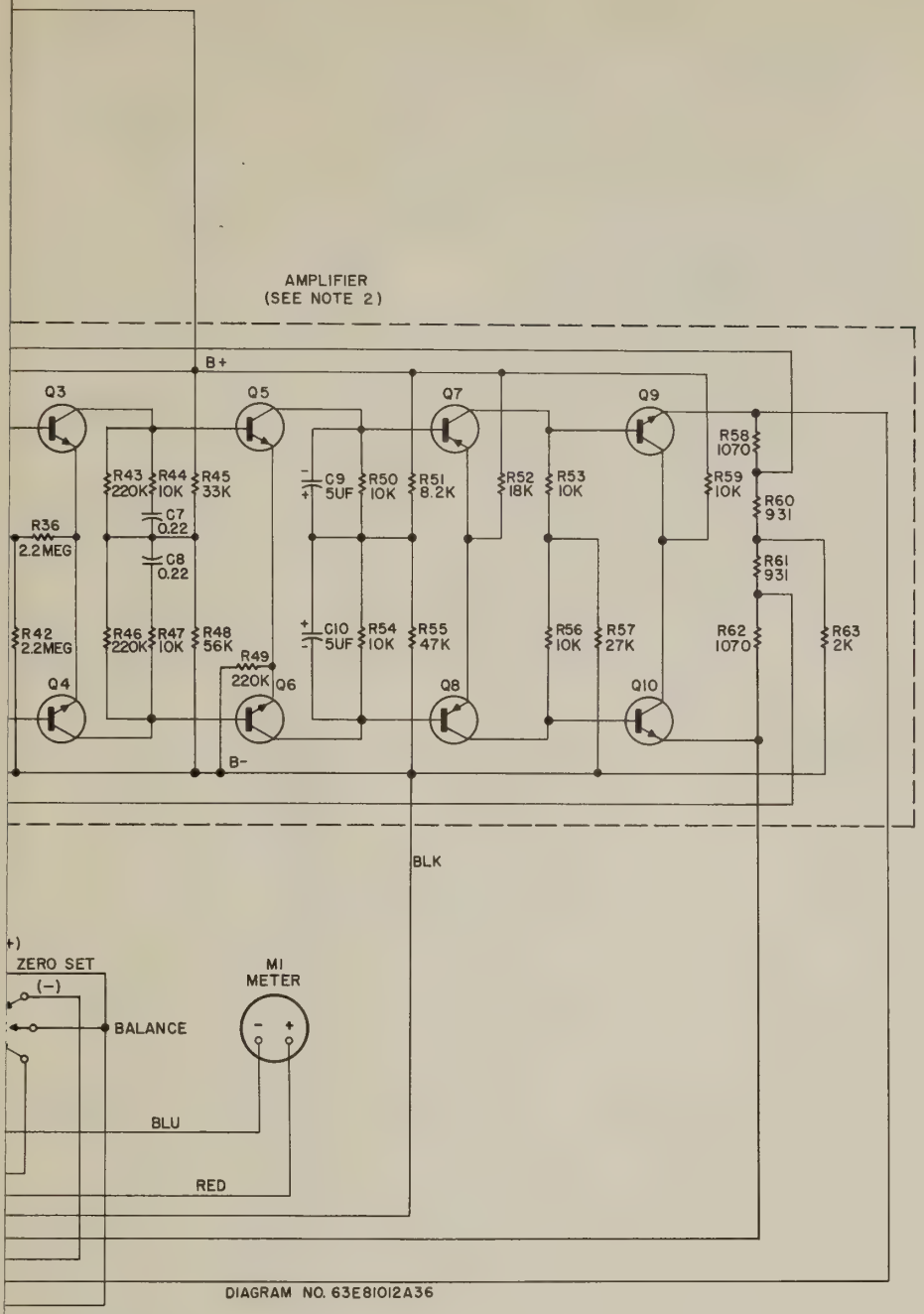
REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
01	SLN6055A	C1	WAS 8K877505	
			NON-REFERENCED ITEMS ADDED TO PARTS LIST	
A	SLN6055A	P1	WAS 28B82156E01	PARTS LIST
			SLEEVE,RESTRAINER ADDED	

PARTS LIST for Schematic Diagram 63A81012A38-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C1	8C82396B05	CAPACITOR, fixed: .0015 uf ±10%; 400 v
CR1	48B811119	SEMICONDUCTOR DEVICE, diode: germanium
P1	9B821396E01	CONNECTOR, plug: female; 1 cont.
R1	6B82475B56	RESISTOR, fixed: 3.9 meg. ±1%; 1/4 w
NON-REFERENCED ITEMS		
	22B82234E01	PROBE TIP
	15B82236E01	PROBE NOSE
	15B82235E01	PROBE END COVER
	1V80726A23	GROUND lead assembly
	43A82231E01	SLEEVE, restrainer

Model SLN6055A RF Probe Accessory
Schematic Diagram
Motorola No. 63A81012A38-A



MODEL TABLE

MODEL NUMBER	CHASSIS SUFFIX	DESCRIPTION
SLN6078A	1	A-C/ BATTERY POWERED D-C MULTIMETER
SLN6030B	1	BATTERY POWERED D-C MULTIMETER
SLN6079A		BATTERY KIT
SKN6008A		POWER CABLE KIT

NOTES:

1. UNLESS OTHERWISE STATED:
   RESISTOR VALUES ARE IN OHMS, K=1000 OHMS, ±½W.
   CAPACITOR VALUES ARE IN MICROFARADS.
   SEE PARTS LIST FOR TOLERANCES.
2. THE AMPLIFIER CIRCUIT BOARD IS NOT TO BE SERVICED IN THE FIELD
3. ALL SWITCHES SHOWN IN EXTREME COUNTER-CLOCKWISE POSITION.
4. COMPONENTS NOT PART OF AMPLIFIER BOARD.
5. WHEN AC INPUT IS USED, THE EXT. GND. IS REQUIRED FOR PROPER OPERATION OF THE INSTRUMENT.

PREVIOUS REVISIONS LISTED
ON BACK OF THIS DIAGRAM

Model S1063A & S1052B Transistorized
DC Multimeter
Schematic Diagram
Motorola No. 63E81012A36-B1

MOTOROLA

OHMMETER ADAPTER

MODEL SLN6205A

(CE2286-K29)

1. DESCRIPTION AND APPLICATION

The Motorola Ohmmeter Adapter, Model SLN6205A, is a battery-powered device for use with any Motorola DC Multimeter. The purpose of the adapter is to provide a higher open circuit voltage (1.5 v d-c) than is available from the d-c multimeter, for measuring the forward and reverse resistance of diodes and transistors. This is actually accomplished by measuring the forward and reverse voltage drop across the junction of the semiconductor. The maximum short circuit current is 1.5 ma (see table) and is insufficient to destroy the semiconductors.

The adapter is built into a housing approximately 2" x 3" x 5-1/2" and uses a size "C" dry cell (not supplied).

2. OPERATION

a. Connect the d-c multimeter leads to the ohmmeter adapter binding posts as follows: The black lead (common) to the black binding post and the voltage probe to the red binding post.

b. Adjust the d-c multimeter zero set and turn the function switch to the (+) OHMS position. Set the range switch of the multimeter to the .1 VOLTS position.

c. Set the range switch of the adapter to the desired range (R X 100, R X 1K, R X 10K).

d. Adjust the INF. ADJUST of the adapter for INF. reading on the d-c multimeter ohmmeter scale.

e. Place the polarity reversal switch of the adapter to the RED POS. position.

f. Place the adapter leads across the diode or transistor and read resistance on the d-c ohmmeter scale.

g. Set the polarity reversal switch of the adapter to the RED NEG. position and read ohms on the d-c multimeter ohmmeter scale.

h. The lower reading of the two taken in steps f. and g. will be the forward resistance of the semiconductor and the higher will be the reverse or backward resistance.

NOTE

If the range switch position of the adapter is changed, re-adjust the INF. ADJUST of the adapter. After using the

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NOTE (Cont'd)

adapter, place its range switch in the OFF position to prevent the battery from discharging should the leads be accidentally shorted.

3. BATTERY CHECK AND INSTALLATION

a. If the INF. ADJUST cannot be made to read infinity (step 2-d above), replace the battery.

b. To replace the battery, remove the top plate of the adapter by removing two screws. Replace the used battery with a new "C" dry cell (see Parts List). The positive side of the battery must be facing the button (insulated) side of the battery holder.

4. OPEN CIRCUIT E, R, AND I VALUES

The following table provides open circuit voltage, source resistance and short circuit current values of the d-c multimeter ohmmeter adapter combination:

Ohmmeter Adapter Range	R X 100	R X 1K	R X 10K
Source Resistance	1K	10K	100K
Nominal Open Circuit Voltage	1.5 V	1.5 V	1.5 V
Short Circuit Current	1.5	.15	.015

5. HINTS ON CHECKING TRANSISTORS

NOTE

Transistors should be measured out of the circuit. Their d-c breakdown voltage (collector to base with open emitter or collector to emitter with open base) shall be not less than 1.5 volts. As the Model SLN6205A Ohmmeter Adapter is primarily intended to check the forward or reverse resistance of diodes, it is suggested that a transistor checker be used for transistors if it is available. The readings shown below are to be used as guides when using the Model SLN6205A Ohmmeter Adapter for checking transistors and are approximate only. Readings may vary between types of transistors.

a. Small Signal Germanium (P-N-P)

(1) Place the slide switch of the adapter in the RED POS. position.

(2) Place the red lead on the emitter and the black lead on the base of the transistor. The resistance should be approximately 200 ohms on the R X 100 range.

(3) Move the black lead to the collector. The resistance should be approximately 2.5K to 10K.

(4) If either reading in step (2) or (3) is near zero or near infinity, the transistor is bad.

b. Small Signal Germanium (N-P-N)

(1) Place the slide switch of the adapter in the RED POS. position.

(2) Place the black lead on the emitter and the red lead on the base of the transistor. The resistance should be approximately 200 ohms on the R X 100 range.

(3) Move the red lead to the collector. The resistance should be approximately 2.5K to 10K.

(4) If either reading in step (2) or (3) is near zero or near infinity, the transistor is bad.

c. Germanium Power (P-N-P)

(1) Place the slide switch of the adapter in the RED POS. position.

(2) Place the red lead on the emitter and the black lead on the base of the transistor. The resistance should be approximately 50 ohms on the R X 100 range.

(3) Move the black lead to the collector. The resistance should be approximately 30 to 500 ohms.

(4) If either reading in step (2) or (3) is near zero or near infinity, the transistor is bad.

d. Small Signal Silicon (P-N-P)

(1) Place the slide switch of the adapter in the RED POS. position.

(2) Place the red lead on the emitter and the black lead on the base of the transistor. The resistance should be approximately 60 ohms on the R X 100 range.

(3) Move the black lead to the collector. The resistance should be near infinity.

(4) If the reading in step (2) is near zero or near infinity, or if the reading in step (3) is not near infinity, the transistor is bad.

e. Small Signal Silicon (N-P-N)

(1) Place the slide switch of the adapter in the RED POS. position.

(2) Place the black lead on the emitter and the red lead on the base of the transistor. The resistance should be approximately 800 ohms on the R X 100 range.

(3) Move the red lead to the collector. The resistance should be near infinity.

(4) If the reading in step (2) is near zero or near infinity, or if the reading in step (3) is not near infinity, the transistor is bad.

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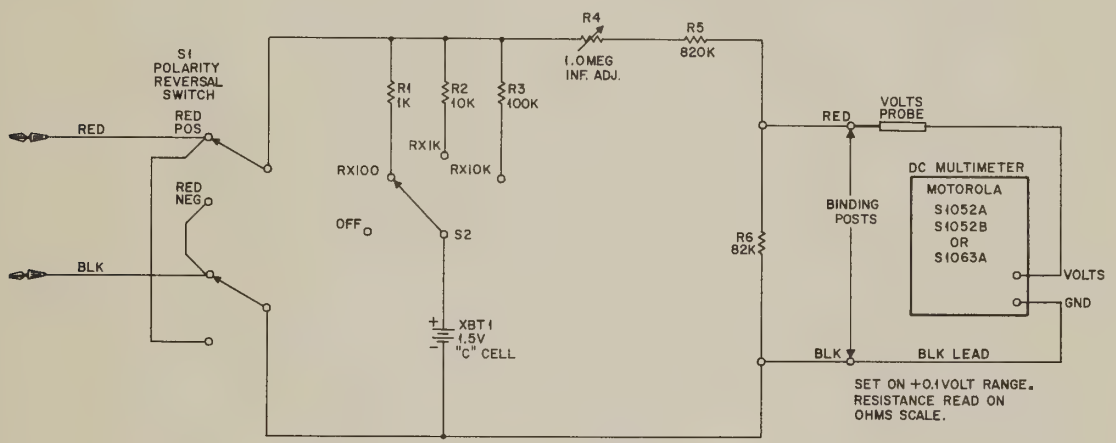

MODEL CHART

MODEL NO.	SUFFIX	DESCRIPTION
SLN6205A		OHMMETER ADAPTER KIT

Model SLN6205A Ohmmeter Adapter
Schematic Diagram

PARTS LIST for Schematic Diagram 63B81107A32-O

SLN6205A Ohmmeter Adapter Kit

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		RESISTOR, fixed: ±5%; 1/2 w; unl. stated
R1	6R6411	1K
R2	6R5556	10K
R3	6R5553	100K
R4	18D82515B06	var; 1 meg ±30%: 0.25 w
R5	6R5773	820K
R6	6R6449	82K
		SWITCH:
S1	40B864400	slide; dpdt
S2	40C82160H01	rotary; 2 p, 4 pos.
		HOLDER, battery:
XBT1	42B82439B01	(for 1.5 v BURGESS No. 130 or equivalent "C" cell)
NON-REFERENCED ITEMS		
	36C82289H02	KNOB, control 2 req'd
	42A82455B01	CLIP crocodile
	14A82456B01	INSULATOR, clip; BLK
	14A82456B02	INSULATOR, clip; RED
	3S8158	SCREWS, tapping; #4 x 1/4; 2 req'd

DC Multimeter

68P81012A35-B

national

MOTOROLA

RADIO COMMUNICATIONS

service